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for the Behavioral and Social Sciences**

Research Report 1732

**The COBRAS Synthetic Theater of War Exercise Trial:
Summary and Report of Findings**

**Charlotte H. Campbell, Roy C. Campbell, Laura A. Ford, David M. Pratt, and
Daniel E. Deter**
Human Resources Research Organization

December 1998

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FOREWORD

The Armored Forces Research Unit of the United States Army Research Institute for the Behavioral and Social Sciences has been actively involved in research and development associated with structured, simulation supported training for armored and mechanized infantry brigades. The developmental efforts of the Armored Forces Research Unit at Fort Knox have focused on both constructive and virtual simulations and ways to use them in supporting collective training.

This project explored linking the constructive simulations of the Brigade/Battalion Battle Simulation (BBS) and Modular Semi-automated Forces (ModSAF) with the virtual simulations of Simulation Networking (SIMNET) and Desktop Reconfigurable Simulators (DRSs) to create a multiechelon training environment for a brigade combat team headquarters and selected supporting and subordinate units. This particular linkage of multiple simulations is referred to as Synthetic Theater of War-Exercise Trial (STOW-ET).

This report summarizes the outcomes of the development process, the resulting configuration of the exercise, the trial, and the formative evaluation of the effort. The evaluation focused on the performance of the technologies which generated the linked simulated environment, the training support package which guided the exercise, and the training value of creating such an exercise. The report addresses the strengths, weaknesses, and challenges of such a training exercise. Not surprisingly, a major conclusion is the need to continue to conduct a series of such exercises in order to gain more experience with the technologies and the exercise design. The complete report on this research and development effort will be released at a later date.

Army leaders and training managers can use this report to help decision makers guide the future development and use of STOW exercises as a part of combined arms training strategies.

ZITA M. SIMUTIS
Technical Director

THE COBRAS SYNTHETIC THEATER OF WAR EXERCISE TRIAL: SUMMARY AND REPORT OF FINDINGS

EXECUTIVE SUMMARY

Research Requirement:

In 1994, the Army Research Institute for the Behavioral and Social Sciences (ARI), in coordination with the Force XXI Training Program and the U.S. Army Armor Center (USAARMC), launched a research and development effort designed to help brigade staffs become proficient in the combat fundamentals that will be required on the digital battlefield. This effort, titled *Combined Arms Operations at Brigade Level Realistically Achieved through Simulation (COBRAS)*, is developing and evaluating structured, simulation-based training programs and strategies to address the training need.

The objective of the COBRAS work that is the subject of this report was to develop and evaluate a Synthetic Theater of War (STOW) exercise for a multiechelon training audience. The evaluation addressed three specific research areas: training support packages (TSPs) and resource requirements, technology and infrastructure requirements, and training value.

Procedure:

COBRAS developers first identified the multiechelon training audience positions for the STOW exercise. These included the brigade commander and staff and the commander and staff of one battalion task force (TF), and the line company commanders, first sergeants, fire support team leaders, and scout platoon of that TF.

The STOW environment included both constructive simulation (the Brigade/Battalion Battle Simulation [BBS] and Modular Semi-Automated Forces [ModSAF]) and virtual simulation (Simulation Networking [SIMNET] and reconfigurable simulators). COBRAS developers worked closely with STOW developers to identify weak links in the technology, recommend additional features and capabilities, and devise stop-gap workaround solutions to technical difficulties for the trial.

The exercise scenario was designed both to provide performance opportunities for the full brigade and battalion audience, and to conform to the capabilities of the STOW technology. The exercise architecture was also designed specifically for the STOW environment. This foundation was then used to construct the TSP materials for the planning, preparation, and execution of one mission, a deliberate attack.

Many of the support positions were staffed by developers from the Fort Knox USAARMC community. Members of the Force XXI Training Program, the COBRAS team, and contracted logistics support staff members for BBS and SIMNET participated as evaluation observers and simulation controllers. The Warthog Observer/Controller (O/C) Team and the Senior O/C Team (16th Cavalry Regiment, Fort Knox) served as observers during the exercise. Because all of these supporting participants were already familiar with their roles and responsibilities, a full TSP was neither needed nor constructed for the trial. All of the

components that the unit members and observers needed were provided, along with all of the appropriate job aids.

The participating unit was the 3rd Brigade, 42nd Infantry Division of the New York National Guard, along with one TF (TF 1-101). The TF deployed to Fort Knox for a week of training in the VTP as part of its annual training, and the 3rd Bde Commander and staff arrived for the STOW exercise the following week.

Findings:

Findings from the trial implementation address training support, technology and infrastructure requirements, and training value. The TSP design and development approach was considered a success. Both personnel and time requirements are heavy but manageable.

The technology and infrastructure were, at the time of the trial, still developmental. As a result, there were many suggestions for improvements and corrections. Still, the overall impression was that the STOW exercise showed the potential for training opportunities not yet offered in simulation.

The trial implementation of the STOW exercise resulted in strong expressions of support from the participating unit for continued STOW and reconfigurable development and use. They also provided a great many points of consideration for improvement.

Products include this report and a companion ARI research report entitled *COBRAS Synthetic Theater of War Exercise Trial: Report on Development, Results, and Lessons Learned* (Campbell, Pratt, Deter, Graves, Ford, Campbell, & Quinkert, in preparation) in addition to the TSP materials themselves. The companion report gives a detailed description of the design, development, and implementation decisions and activities.

The summary and recommendations in this report are presented to assist training developers, including Force XXI policy-makers, as they continue to advance and promote the Force XXI Training Program and STOW-type exercises in particular.

Utilization of Findings:

This report presents a summary of the development of the COBRAS STOW Exercise and the lessons learned during the exercise development and implementation. As continued emphasis is placed on providing low-resource, cost-effective training for increasingly complex segments of the brigade combat team, this report can lead other training developers into the selection of effective design and implementation strategies.

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INTRODUCTION

Between 24 February and 6 March 1998, the Directorate of Training and Doctrine Development (DTDD)¹ of the U.S. Army Armor Center conducted a unique training exercise at Fort Knox, Kentucky. The exercise was a multiechelon training opportunity for members of the 3rd Brigade, 42nd Infantry Division (Mechanized [M]) of the New York National Guard. It served as both a training opportunity for the members of the 3rd Brigade and as a research opportunity for exploring the use of linked simulations.

The exercise employed linked virtual and constructive simulations, and was supported by two Fort Knox-based observer/controller teams. Government and civilian contractor teams worked collegially throughout the process of planning, development, and implementation. The linked simulation environment is referred to as a Synthetic Theater of War (STOW), and the February-March 1998 exercise is referred to as the STOW Exercise Trial (STOW-ET).

Because of the dual purposes of training and research, the participating unit was the “experimental unit” in this large-scale experiment. The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) and its contractors, the Combined Arms Operations at Brigade Level Realistically Achieved Through Simulation (COBRAS) Team, conducted the evaluation during the trial implementation. The evaluation had a threefold focus: simulation and infrastructure requirements, training support and resource requirements, and training value.

This report summarizes the STOW-ET implementation and findings. More details about development, implementation, and results are contained in a separate ARI report, *The COBRAS Synthetic Theater of War Exercise Trial: Report on Development, Results, and Lessons Learned* (Campbell et al., in preparation).

Background

The STOW-ET was the latest in a series of developmental activities on two axes: STOW-type training and structured simulation-based training. Efforts within the STOW axis are examining linked simulation technologies, and include STOW-Europe (1995), STOWEX-96, STOWEX-97 and STOWEX-98 (summarized in Campbell et al., in preparation).

¹ Acronyms and other abbreviations used in this report are defined at the end of the report.

Research along the second axis is exploring structured simulation-based training and TSP structures. Related projects include the Virtual Training Program (VTP), COBRAS Brigade Staff Exercise (BSE), and COBRAS Brigade and Battalion Staff Exercise (BBSE). These exercises target armor/heavy units from platoon through brigade staff levels. The exercises range from short, mission execution situations that are accomplished in a few hours, to complex, multi-mission, multiechelon exercises requiring 24-hour operations over several days.

Utilization	The STOW-ET was designed to provide information useful for additional development and testing, moving both technology and training design closer to the goal of cost effective, accessible training that provides significant training value to users. This report is addressed to decision-makers who need a broad overview of the exercise trial, the lessons learned, and a set of recommendations for continuing development.
Proponency	<p>The principal agencies and organizations involved in planning and conducting the STOW-ET included:</p> <ul style="list-style-type: none">• DTDD, Force XXI Training Program (FXXITP) – responsible for STOW architecture and infrastructure issues; liaison with National Simulation Center (NSC) and the Simulation, Training, and Instrumentation Command (STRICOM).• 16th Cavalry Regiment, Fort Knox – provided observer/controllers (O/Cs) from the Warthog Team and the Senior Observer Controller Team (SOCT) and simulation site staff from the contractor logistics support (CLS) teams. These teams routinely provide training support for virtual and constructive simulation-based exercises at Fort Knox.• ARI and its contractors, the COBRAS Team – provided the exercise concept and plan, the TSP for the exercise, exercise control, and exercise evaluation.

RESEARCH QUESTIONS	The three areas of interest for the STOW-ET were developed jointly by the DTDD FXXITP and ARI. They address the technology and operational requirements, the training support requirements, and the training value. Results of the trial were also to be used to outline recommendations for future STOW exercise development and use.
Focus	The three areas of interest for the STOW-ET were restated as research questions by ARI and FXXITP: <ul style="list-style-type: none">• What simulation and infrastructure capabilities are needed to make STOW-type training possible?• What are the unique challenges and considerations associated with training support for a structured STOW-type exercise?• What is the value added by training in a STOW-type environment?
Data Collection	The primary data collection efforts for addressing the research questions included direct observation and documentation by the COBRAS and FXXITP staff, structured individual and group interviews conducted with selected members of the trial unit and supporting participants, and questionnaires distributed to all participating members of the trial unit and supporting participants.

CONTEXT

The STOW-ET was conducted 28 February-6 March 1998 at Fort Knox, Kentucky, after a preparation and development period that began in July 1997. The physical layout was distributed among three buildings, as shown in Figure 1. The two buildings housing the Simulation Networking (SIMNET) systems (2020 and 2021) are collocated, while the third (Skidgel Hall, Building 1724) is about a half-mile away.

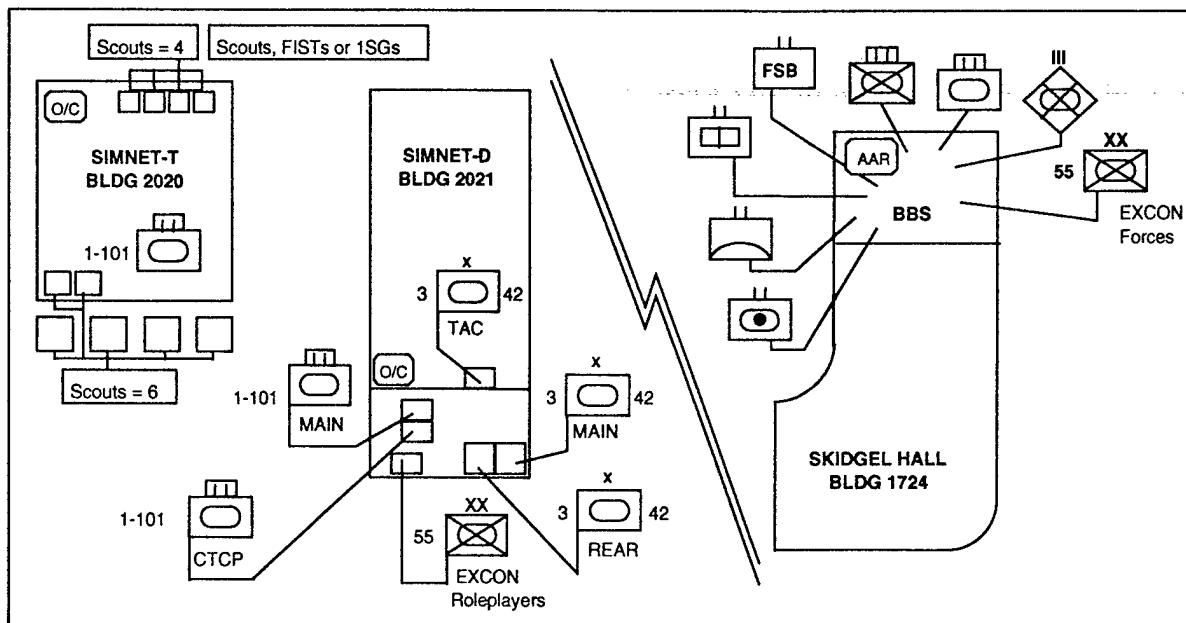


Figure 1. Physical layout for STOW-ET.

Simulation Environment	The STOW-ET employed linkages among the virtual simulations of SIMNET and the Desktop Reconfigurable Simulators (DRSs), ² and the constructive simulations of Modular Semi-Automated Forces (ModSAF) and the Brigade/Battalion Battle Simulation (BBS). A more technical description is given in the <i>Fort Knox STOW-A 1.6 Handbook</i> (DTDD, 1998).
Participating Unit	The 3 rd Brigade (Bde), 42 nd Infantry Division (ID) (M) participated as the STOW-ET unit, with division staff support from the 42 nd ID (M). For the STOW-ET 3 rd Bde was organized as two armor and one mechanized infantry battalions, with supporting field artillery, logistics, engineer, and air defense artillery. Only one battalion task force (TF 1-101) deployed to Fort Knox with the 3 rd Bde. Other members of 42 nd ID (M) participated to represent the other two battalions, as described below.
Simulation Control	Figure 2 portrays the 3 rd Bde and TF 1-101 organization and simulation representation for the STOW-ET. Division assets were controlled from a BBS workstation by members of the 42 nd ID (M) staff, serving as the division response cell. They were supplemented and assisted by COBRAS and FXXITP staff. The 3 rd Bde staff occupied main, rear, and tactical command posts (CPs) located inside the SIMNET-D facility. The 3 rd Bde Commander also had the reconfigurable combat vehicle simulator (RCVS) DRS for use as his command vehicle, allowing him to move around on the battlefield and observe the virtual (SIMNET and other DRS) and semi-automated (BBS- and ModSAF-generated) forces. TF 1-101 participated with three armor companies and one mechanized infantry company. The battalion staff operated a main CP and combat trains CP (CTCP) inside the SIMNET-D facility.

² Two types of reconfigurable simulations were used. One is the Advanced Research Projects Agency (ARPA) Reconfigurable Simulator Initiative (RSI), which is a desktop representation of the basic controls with dynamic visual displays of the simulated terrain and environment. The other is the Reconfigurable Combat Vehicle Simulator (RCVS), a large simulator contained in a cabinet representing the commander's vehicle. Both are referred to as Desktop Reconfigurable Simulators (DRSs), although the RCVS is not, in fact, desktop.

The TF used the 40 M1A1 and 10 Bradley Fighting Vehicle (BFV) SIMNET simulators for its maneuver elements, and 7 DRSs for 3 fire support team vehicles (FIST-Vs) and 4 1SG vehicles (configured as HMMWVs); one 1SG operated from a ModSAF workstation. Combat Service Support (CSS) functions for TF 1-101 were controlled and accounted for in BBS.

The leader and section leaders of the TF 1-101 scout platoon occupied five of the DRSs (configured as HMMWVs); the other section vehicles were generated by ModSAF.

The remaining 3rd Bde assets, including the other two TFs, were represented by response cell teams who controlled the functions from BBS workstations. The opposing forces (OPFOR) and the division assets were also controlled from BBS workstations.

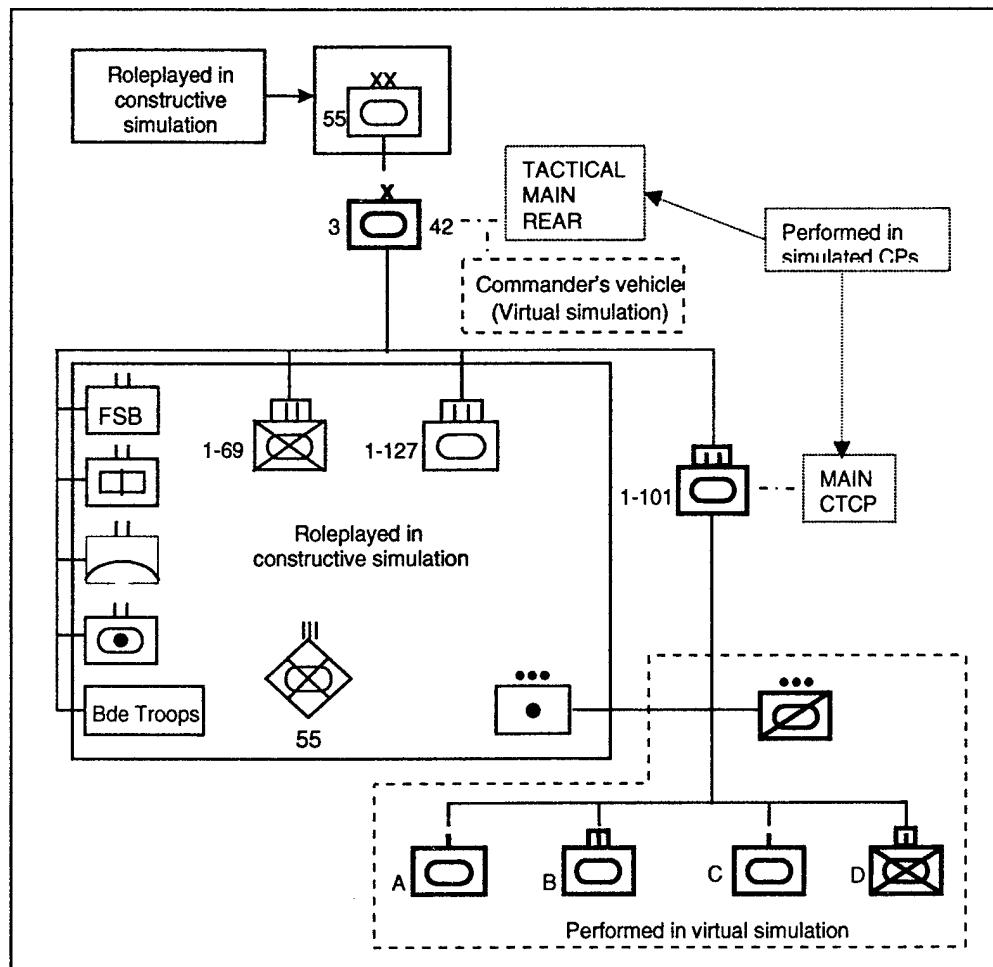


Figure 2. Task organization of 3rd Bde, 42nd ID and TF 1-101 for the STOW-ET.

Communications

Simulated frequency modulation (FM) radio communications and telephone lines linked all the workstations, CPs, and simulators in a configuration consistent with actual communications networks within the brigade.

Four dedicated telephone lines were linked in a conference call ("hot loop") configuration to support administrative communications requirements for exercise controllers and observers.

The communications infrastructure is shown in Figure 3.

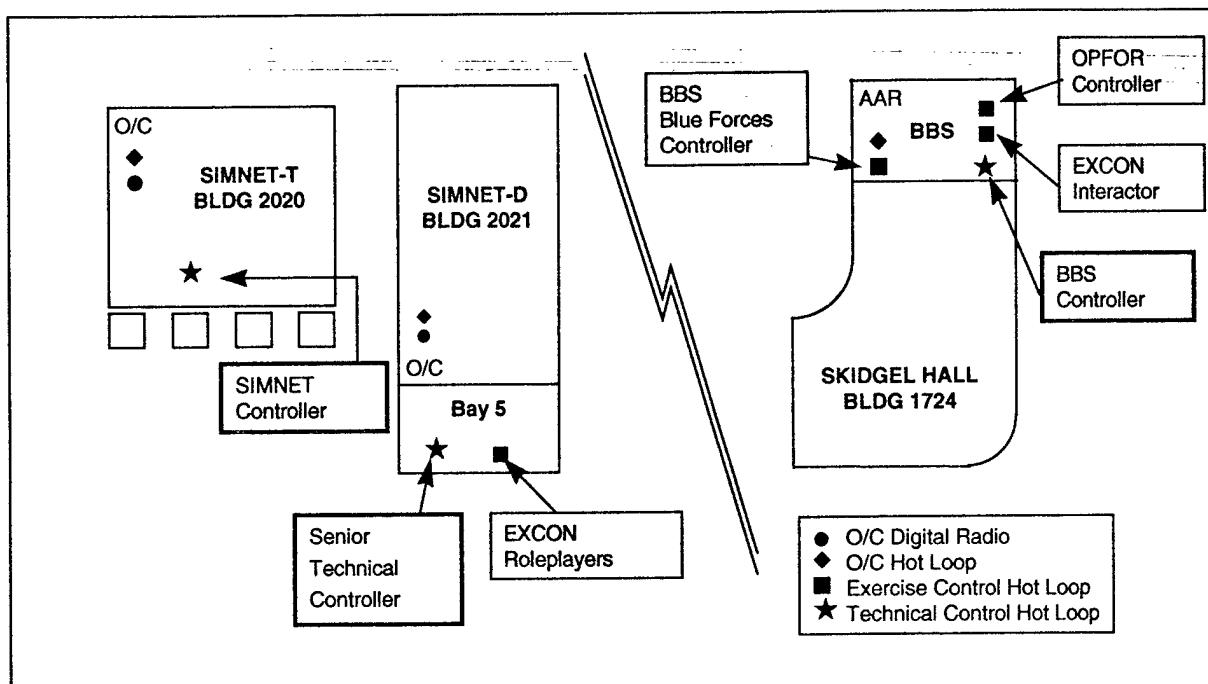


Figure 3. Communications infrastructure for the STOW-ET.

Scenario

3rd Bde, 42nd ID (M) performed a deliberate attack (DATK) mission against a Krasnovian Heavy OPFOR in a simulation-based National Training Center (NTC) locale. The exercise scenario included receipt of the mission, planning, preparation, execution of the DATK, and consolidation and reorganization. The mission was executed twice, using the same scheme of maneuver and starting conditions each time.

Exercise Time Line

The exercise time line featured phased entry of participating units into the exercise, beginning with the 3rd Bde receiving the division operations order (OPORD) on the first day. On the second day, the TF 1-101 leaders and other assets joined in, and the scouts, the TF 1-101 companies, and the TF support platoon participated during the final three days. This allowed TF 1-101 subordinate elements to continue training in VTP exercises while the higher echelons planned.

The training schedule is shown in Figure 4.

Unit	Day 1	Day 2	Day 3	Day 4	Day 5
Brigade Staff	Receive Div order, begin planning	Continue planning through order production	Issue order, complete recon planning	Begin recon, conduct rehearsals	Execute
TF Staff	VTP	Begin planning, parallel plan with Bde	Receive Bde order, continue planning through order production	Begin recon, Bde rehearsal, issue order, conduct TF rehearsal	Execute
Company Teams	VTP	VTP	Troop leading, begin planning	Receive order, plan, TF rehearsal	Execute
Support Platoon	VTP	VTP	Begin planning CSS support	Receive order, plan, TF rehearsal	Execute
Scouts	VTP	VTP	Recon planning	Conduct recon	Complete recon

Figure 4. Training schedule for the STOW-ET.

TRAINING SUPPORT PACKAGE	<p>The TSP for the STOW-ET included:</p> <ul style="list-style-type: none">• preparation materials for 3rd Bde and TF 1-101 concerning the unit's starting conditions and the Road to War;• performance objectives materials addressing the five main elements of the training audience: brigade staff, TF staff, company leaders, scout platoon, and support platoon leader;• division OPORD with overlays for the DATK;• exercise guides for each BBS workstation team;• simulation files, documentation, and exercise-specific operating instructions;• guidance for the Exercise Director, OPFOR controller, and division staff roleplayers; and• observation and feedback guidance and after action review (AAR) materials for the Warthogs and SOCT.
Performance Objectives	<p>The specific performance objectives for the exercise were focused on each element of the training audience, and indicated the tasks and activities that training audience members would practice and on which they would receive feedback.</p> <p>The performance objectives for the STOW-ET included:</p> <ul style="list-style-type: none">• Brigade staff – Conduct Military Decision-Making Process (MDMP), Parallel Planning with the TF, Plan and Manage Reconnaissance, Execute the Brigade Fight• Task Force level – MDMP and Parallel Planning with the Brigade, Plan and Manage Reconnaissance, Execute the TF Fight• Company level – Prepare for Combat (Troop Leading), Execute• Support Platoon – Plan and Execute Concept of Support• Scout Platoon – Plan and Execute Reconnaissance <p>The performance objectives materials included techniques and procedures for the training audience, as well as observation and feedback guidance for the observers.</p>

Observation and Feedback	Observation and feedback for the 3 rd Bde staff was provided by 14 members of the SOCT. Observation and feedback for other elements of the primary training audience (TF 1-101, its companies, the support platoon and the scout platoon) was provided by 25 members of the Warthog O/C team.
Exercise Control	<p>One of the COBRAS staff served as the Exercise Trial Director for the planning and preparation period leading up to the exercise. The 42nd ID (M) Assistant Division Commander-Support was the Exercise Director during the exercise itself. Throughout the exercise, he was supported and mentored by the COBRAS Exercise Trial Director.</p> <p>Members of the FXXITP, the COBRAS Team, and the CLS staff were responsible for operation of the simulation linkage controls.</p> <p>Members of the COBRAS Team had oversight of the BBS division, brigade, and battalion workstations, and controlled the OPFOR in BBS.</p> <p>Exercise controllers from the Warthog team operated the ModSAF workstations.</p>

FINDINGS AND RECOMMENDATIONS

This section summarizes the principal findings in each of the three research areas:

- technologies,
- training support requirements, and
- training value.

Details are contained in a research report entitled *The COBRAS Synthetic Theater of War Exercise Trial: Report on Development, Results, and Lessons Learned* (Campbell et al., in preparation).

The findings reported here have both near-term and long-term implications. They speak especially to prospects for future STOW exercise trials and to the developmental and implementation requirements for such trials. The major implications are summarized below.

Findings on Technologies

The Fort Knox STOW architecture was intended to support training that links all of the elements of the brigade combat team. But before *training* can be accomplished, the technical weaknesses that obstruct training must be fixed. The goal is not a perfect system, but, insofar as possible, training detractors must be eliminated. The efficacy of the Fort Knox STOW architecture as part of a training system will be more accurately gauged when certain technical concerns, described in this section, are resolved.

Because the systems are still developmental, these findings are predominantly critical, pointing out areas for improvement. This is not a blanket condemnation of the technologies, but rather a factual reporting of the STOW-ET findings. The comments are organized in seven areas:

- Translation between simulations
- Desktop reconfigurable simulations
- Portrayal of environmental conditions
- Communications
- Physical setup and locations
- AAR functionality in STOW

Translation between simulations for weapons systems, battlefield effects, and CSS functions

When the simulation environment does not accurately portray weapons systems and their effects, participants cannot gauge their own situation.

Incomplete translations in the STOW-ET included the following:

- Only about 40% of the vehicles and weapons systems modeled in BBS can be translated correctly into ModSAF. Only about 50% of vehicles and weapons that are modeled in ModSAF translate correctly from ModSAF to SIMNET. Combat assets translate best, followed by combat support, followed by CSS assets. In the STOW-ET, extensive workarounds were required to compensate for these technical weaknesses.
- Dismounted forces and their associated weapons do not translate from BBS into SIMNET. This particularly affected scouts and dismounted infantry, but also affected the ability to portray realistic Level I and Level II rear area threats.
- Aircraft modeling does not translate between simulations. Aircraft were flown independently in both ModSAF and BBS in order for all effects to be modeled. This was a complex and time consuming requirement, and has the potential for introducing inconsistencies and confusion.
- Except for M109A6 HE rounds, no indirect fire artillery correctly translates from BBS all the way through to SIMNET. This results in all artillery effects looking the same; there is no way to distinguish among effects in terms of type, size or volume. This seriously affected reporting, battle damage assessment (BDA), and battle tracking. Additionally, none of the simulation systems allows forward observers to execute their roles in Copperhead missions, negating any training value of planning to employ these munitions in simulation.
- Engineer equipment such as earthmovers, armored vehicle launched bridge (AVLB), and Volcanoes do not translate into SIMNET. The mine clearing line charge (MICLIC) translates to SIMNET only as a trailer and provides no signature.

While BBS portrays CSS functions very well, very little of that translates to ModSAF and SIMNET. Specifically:

- Attempts to recover and repair ModSAF or SIMNET vehicles using BBS CSS capabilities were unsuccessful.
- Resupply in ModSAF and SIMNET can be done in the tailgate mode, but problems with controlling the vehicles made this function impractical to apply. Further problems arose because some units in BBS lose all their fuel and ammunition when they are disaggregated (translated from constructive to virtual environments).
- No personnel losses occur in SIMNET, therefore the casualty tracking based on SIMNET data cannot correspond with BBS results. Personnel roll-up reports in BBS summed results incorrectly throughout the exercise. The data were so unreliable that the training audience lost confidence in their status reports and staff estimates.

CSS play is essential to the training design of the exercise conducted. Realistic CSS play is dependent on accurate and timely reports. When CSS could not be played because of system problems, the training audience expressed frustration and disillusion with their role in the exercise and much of the perception of training value from their participation evaporated. The inability to portray the full capabilities of transportation, CSS vehicles, and classes of supply resulted in the workaround requirement for “magic” resupply. When this happened, the logistics training audience ceased to have a significant role in the exercise.

Not all of these problems were caused by the STOW linkage. Some of them have existed for some time in BBS, ModSAF, or SIMNET. However, the training audience requires a single seamless environment in order to conduct planning preparation and execution realistically. Making conceptual translations to compensate for technology weaknesses compromises the realism of the environment and the potential value of the exercise.

Desktop reconfigurable simulations supporting scout participation

Reconnaissance and utilization of scouts was confounded by many problems which affected training the brigade combat team's reconnaissance and surveillance plan:

- Scouts in BBS can dismount but scouts on the DRS cannot.
- Dismounted scouts in BBS lose all their small arms when they are disaggregated and modeled in the SIMNET environment.
- Scout vehicles must give up all .50 cal ammunition when disaggregated and modeled in SIMNET or else they cannot move, leaving them without any protection.

Although involving the scout platoon may have provided valuable troop leading authenticity and teamwork, the DRSs did not fully portray or support the scout reconnaissance mission itself.

Portrayal of environmental conditions in SIMNET

Environmental condition portrayal that is still needed includes both ambient conditions (light and weather) and ground conditions (ability to dig or mark). First, variable weather and light conditions can be entered in BBS but cannot be portrayed in ModSAF/SIMNET. As a result, all operations took place in daylight and in neutral or non-existent weather. This was unrealistic for planners and commanders as well as for crews. It obviated a vital part of the S2 function and did not force planners to integrate this important facet into their plans. Similarly, smoke cannot be employed in SIMNET. This frustrated initiatives by planners to realistically employ this combat multiplier.

Second, no terrain modification is possible in SIMNET, eliminating portrayal of vital engineer functions. The exercise scenario called for a DATK, which should have involved maximum utilization of mobility, counter-mobility, and survivability assets and principles of engineer employment. Unfortunately, minefield signatures are non-existent; all minefields are perfectly hidden, denying the use of visible minefields for deception and canalizing. When minefields were reconnoitered and marked in BBS, this fact did not transfer to SIMNET, creating confusion in execution and battle tracking. Lane marking in minefields was limited to a single SIMNET-specific portrayal, which did not support the full array of doctrinal marking requirements.

Communications

A major part of the STOW-ET preparation was establishing and maintaining communications between the locations to replicate tactical nets and provide administrative links for the control of the exercise. These communication requirements exceeded anything already established at Fort Knox for existing training programs. Implementing and maintaining communications was a major effort of the exercise requiring a full-time person for several weeks.

Nonetheless, the system was not always optimally reliable. Some of this was undoubtedly due to user unfamiliarity with the communications systems, which were unlike their normal mobile subscriber equipment (MSE) radios. In other cases, the communications systems could not bear the heavy load of the number of users, resulting in frequent reports of channel bleed-over and instances of particular nets not being represented.

For staff training and CP operations, information transfer and communications links are vital. Yet the system, as currently installed, lacks capability for replicating data transmission, tactical facsimile (TACFAX), MSE links, computer links, phones, Joint Surveillance Target Attack Radar System (JSTARS) downloads, and data retrieval. A training environment that does not offer a greater semblance of realism in this arena will only be considered adequate for a short period of time. As the simulation system matures and offers more realism, the same will be demanded of the communications systems.

Effects of physical locations of the CPs on unit and observer/controller communications

During the exercise, 3rd Bde's main CP and rear CP were separated only by a 6-foot partition, and the tactical command post (TAC) was located about 100 feet away. Similarly, the main CP and CTCP for TF 1-101 were directly next to each other, and the entire TF CP complex was about 50 feet from the 3rd Bde main and rear CP locations. This allowed for unrealistically easy face-to-face contact between persons at the different CPs.

When the siting was being done, this did not seem to present a problem, because traffic between CPs could be readily controlled. However, problems with the normal radio as the means of communications forced training participants to find other ways to pass messages and share information. It was very easy for participants to simply talk over partitions or walk around the corner, especially when they were unable to use their radios.

At the same time, the physical separation among the simulation sites made communications among observers difficult. The BBS site is about a half-mile from the two SIMNET buildings, which are side-by-side. Because meetings among exercise control personnel were often impromptu, it was difficult to assemble all of the appropriate observers and simulation controllers to provide input on decisions affecting exercise pace and direction.

STOW features to support AAR functions

In exercises that focus on staff performance at brigade or battalion level, most of the observer information is collected from direct observation of the staff members. In lower echelon exercises, where most of the activity occurs on the battlefield, and mostly during execution, a see-all workstation is essential for obtaining ground truth about events.

The STOW-ET, as a multiechelon exercise, required that observers be positioned to observe both the training audience performance and battlefield activity and effects. However, the AAR workstation in the SIMNET facility was not see-all: Only elements that had been translated to SIMNET or generated in ModSAF were visible to the observers. This meant that observers were unable to track the battle with any more precision than the training audience members whom they observed. Additionally, they were unable to show the aggregated forces during playbacks at the AARs.

The BBS workstation set aside for observer use, located at the BBS simulation site (about a half-mile from the building housing the 3rd Bde CPs), was see-all. But the playback capabilities in BBS are screen captures at isolated points in time, rather than dynamic presentations of actions. Observers felt that AARs conducted using BBS playback were not sufficiently informative to justify the time.

Recommendations Concerning Technologies	Based on the findings summarized above, two recommendations are offered concerning the technologies and the physical layout of the STOW training environment.
<i>1. STOW developers need continued trials of the STOW exercise in order to test upgrades to the systems.</i>	<p>Developers of the STOW linkages and software rely on system tests to determine whether entities translate properly from one environment to another. But only by using the "soldier in the loop" can developers know whether the translations and representations are adequate. Some translations can be imperfect without affecting training value, while others are critical. Developers and subject matter experts make their best estimates of the critical elements, but will always require trials with representative training audiences to verify their estimates.</p> <p>The degree to which the STOW technology can ever be perfected using the legacy systems of BBS and SIMNET is questionable. However, the lessons learned and indicators of likely areas of training benefit should be useful to developers of future systems, including Warfighters' Simulation (WARSIM) 2000 and Joint Simulation System (JSIMS).</p>
<i>2. Many improvements to the STOW technologies, communications systems, and physical layout can and should be made before units participate in additional trials.</i>	<p>Before units participate in continuing STOW development, the full system of technologies, communications, and physical layout must be improved.</p> <ul style="list-style-type: none">• First, STOW technology improvements are needed in order to conduct additional STOW training. While it is understood that this is an ongoing process, it should be possible to effect and test significant software improvements prior to involving units in trials. Although testing the realism and utilization of features requires soldiers in the loop, enough data are available on improvement needs that the decision-making and work can be done without soldiers.• Second, upgrades to the separate simulations (BBS, SIMNET, ModSAF, and the DRSSs) would also greatly enhance the value of the exercises. The requirement for participants to make cognitive leaps in processing information is a distraction to training.

- Third, communications systems must be improved. Despite the major accomplishments in providing communications links, this was still cited by participants as a shortcoming, both during and after the exercise. Future replications of STOW-type exercises at Fort Knox must include the requirement to improve the realism and reliability of communications.

Future training exercises are likely to make this serious shortcoming in technical maturity more apparent, particularly in multiechelon training. The replication of digital systems and the bottom-up, top-down model of the Army Tactical Command and Control Systems (ATCCS) are immediate considerations for any planned training setting. Work will be required soon to upgrade the existing communications architecture of the Fort Knox SIMNET, BBS, and STOW environments to one that meets information age training requirements.

- Fourth, the issue of relocating CPs to provide greater distances between them and to discourage inappropriate face-to-face contacts appears to be minor and easily addressed. Relocation of simulation systems to collocate the various control teams and observers is a much greater undertaking. Solutions that enhance control communications without requiring the movement of simulation systems should be explored first.

Findings on Training Support Requirements

For structured simulation-based training, the training support requirements include the scenario specifications and TSP as well as the personnel required to implement the exercise. Because of the experimental nature of the STOW-ET, not all of the TSP elements were constructed, used, or evaluated. Instead, developers involved in the trial performed the required duties and, in the process, identified specific contents for TSP materials.

The STOW technology is still under development, and is still subject to continual and frequent improvement. As a result, the training implementation model and the corresponding TSP for using STOW will continue to change. The findings described below are in three categories:

- Scenario and TSP development
- Training audience and personnel support
- Scheduling considerations

The findings themselves should be regarded as relevant only to the STOW-ET, although there are valuable implications and lessons for continuing development and testing.

Scenario and TSP development for the STOW environment

The STOW-ET scenario and TSP materials were developed using methods that had been used successfully during previous related efforts. The methods are not unique to any particular simulation or training need, but are customized for every application. These methods worked quite satisfactorily for STOW scenario and TSP development.

The greatest development challenge was related to the STOW technology itself. Because the technology is still under development (as discussed below), a variety of workaround solutions were generated to cope with less fully developed aspects of the simulation. Once tested and documented, these workarounds had to be included in the TSP materials so that roleplayers and interactors could perform them.

As the simulation technology matures, the workaround requirement should shrink and eventually vanish. The TSP for future STOW-type exercises will more closely resemble TSPs developed for related structured training programs.

Despite the novelty of the STOW architecture, the basic TSP structure and development method were easily adapted for the STOW-ET. Even though, as described earlier, some components of the TSP were not prepared for the trial, placeholders for those components were in place. This was not because the TSP model was inadequate, but rather because the trial served as the opportunity to determine what the actual content of those components should be.

Training audience and personnel support

The 3rd Bde, 42nd ID (M) and TF 1-101 provided 255 people as part of the training audience. Of these, 48 were staff located in the 3rd Bde CPs, in the TF main CP, or in the TF CTCP. The remaining 207 participants were positioned in SIMNET or DRS simulators as crewmembers within TF 1-101. Thus all of these persons were members of the training audience.

In addition to the training audience, however, the STOW-ET required about 48 FXXITP, COBRAS, and CLS personnel, over 40 SOCT and Warthog team observers, and an additional 43 persons from 42nd ID (M) in technical and control roles. While much of this support is duplicated in any BBS exercise or SIMNET, there was a significant portion of support generated just from the STOW linkage requirements. Extra controllers and operators worked to keep the scenario running when the inevitable system failures occurred, so that the use of simulation would continue to be transparent to the unit.

Another contributor to the personnel support burden was the fact that the participating unit was a National Guard unit, away from its home station. Roles that would normally be filled by division, a sister brigade, or the brigade's other battalions were instead assumed by COBRAS staff. These included the positions of Exercise Director during the planning and preparation for the exercise, COBRAS Coordinator, Blue Forces Controller, and OPFOR Controller. Additionally, nearly 40 SOCT and Warthog observers and controllers supported the exercise.

Clearly, STOW-type exercises open the way to integrating training for many more participants than can typically be included in simulation-based exercises.

However, a STOW-type exercise also has more control stations than either a SIMNET-only or a BBS-only exercise. Therefore, the controller need should still be expected to be higher than would be required for single-simulation exercises. The benefits of training for an expanded audience must be balanced against resource costs.

Training schedule considerations

Multiechelon training such as was provided in the STOW-ET brings together personnel from the platoon through division levels. However, the levels of activity for different echelons peak at different times during the course of a mission. As a result, platoons and companies in simulation would be essentially idle during the brigade's intense planning activities.

In order to keep the training activities at valuable levels throughout the training period for all personnel, planners of the STOW-ET devised a schedule that involved VTP training for platoon and company team personnel while the battalion and brigade were engaged in planning and preparation. This also allowed units in SIMNET and DRSs to become familiar with the operating requirements of the simulation environment.

The risk in this type of scheduling is in requiring soldiers to spend too much time in their virtual vehicles. Simulation fatigue at the end of the two weeks of virtual training was reported by many participants, whose STOW-ET was preceded by a week of VTP exercises.

Recommendations Concerning Training Support	<p>The following recommendations are based on the assumption that STOW technologies will continue to be developed, improved, and tried out with units. In order to conduct trials with units, TSPs and other training support will be needed. These recommendations lay out the fundamental and immediate requirements for continuing technology development support.</p> <p>They also address long term requirements, including additional evaluation of TSP components and personnel support infrastructures.</p>
<i>1. Implementation of STOW training will require additional TSP work.</i>	<p>The current version of the STOW TSP is only partially complete and will need additional materials before it can be used again. Specifically:</p> <ul style="list-style-type: none">• It contains comprehensive tactical materials and unit preparation materials.• Simulation files and documentation will require extensive reconstruction for future implementations. Already (in October 1998) the simulation is different from what it was in February 1998, at the beginning of this STOW trial. In general, the simulation archive files (the files that define starting conditions) are not upwardly compatible. Additionally, some of the simulation improvements will cause workarounds that were incorporated in the STOW-ET versions to be unnecessary.• As the STOW and individual simulations are changed, instructions for roleplayers and interactors will require corresponding revisions. Those instructions were written for the existing version of the STOW technology.• Materials for the exercise management require additional testing in a trial. The Exercise Director and OPFOR Controller guides were available for the trial, but were significantly expanded thereafter. Specific instructions for the STOW Coordinator (the Exercise Director's principal assistant) and the Blue Forces Controller must be incorporated in appropriate guides. These roles were carried out by COBRAS staff and written instructions were unnecessary for the trial. Thus the effectiveness of the printed instructions has not yet been tested. <p>Preparation for the STOW-ET spanned a period of eight months for preparation of the exercise and the TSP. A period of at least four months should be allowed for making revisions and completing a TSP for another iteration.</p>

2. Near term development should focus on single site (nonexportable) STOW training.

The preliminary findings concerning the STOW exercise model, TSP, and technology status described above are applicable to the situation at Fort Knox. It would be premature to try to generalize the findings to any discussion of an exportable STOW exercise for use at other sites, because of the still experimental and developmental nature of the entire implementation and infrastructure model.

The most cost-effective near-term implementation model would specify a single STOW training site, located at Fort Knox. The model would include all of the specifications for site preparation and unit preparation, and units would rotate to Fort Knox-STOW just as they do to the VTP and to the combat training centers (CTCs). The infrastructure established for the STOW-ET would require certain upgrades, but the foundation is in place.

Within this model, however, the requirement for exercise controllers and unit observers is placed on Fort Knox. Unless units are able to fill control positions (e.g., Exercise Director, Blue Forces Controller) with fairly senior personnel from within their own resources, Fort Knox would staff the control roles. Because of the size of the training audience, the requirement for about 40 observers is unlikely to be reduced over time; these positions, too, must be staffed by Fort Knox.

3. Decision-makers must consider the personnel costs involved in STOW-type training.

It is apparent that the conduct of an exercise such as the STOW-ET comes at a cost. But it should be emphasized that *little of the support and preparation time was borne by the unit.*

All training involves some expenditure of resources to support the training. While simulation-based training is generally cited as a way to save OPTEMPO, it also has its own costs. Estimates of the cost of experimental exercises such as the STOW-ET must be balanced against the understanding that support for developmental trials is generally more demanding than support for later applications should be. It should also be balanced against the benefit to the unit, whose members were able to prepare for the exercise during regular weekend drills.

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- 4. TSP developers need continued trials of the STOW.*
- Assuming each trial using STOW technologies would test changes in technology capabilities, developers of exercises and TSPs would be able to collect data pertaining to training design and implementation models. This information is necessary for completion of the STOW TSP. Without these trials and a focused formative evaluation, TSP developers are relying solely on experience with other programs to modify the exercise design and support packages.

Findings on Training Value	<p>One purpose of the STOW-ET was to evaluate the quality of training that could be conducted in this type of exercise. The trial was not designed to objectively evaluate the effects on specific training outcomes. Observations of the trial implementation and discussions with training audience members and observers were used to identify ways in which the STOW exercise may add training opportunities. Also identified were ways in which it does no more than duplicate the training found in existing programs.</p> <p>The findings are organized into two topics:</p> <ul style="list-style-type: none">• Participant reactions• Duplication of existing training programs
<i>STOW-ET participant reactions to the training</i>	<p>Support for use of STOW-type exercises for multiechelon training was common throughout the training audience. In interviews and on surveys, the platoon, company, and scout participants candidly reported their difficulties with the communications and simulation, yet expressed positive reactions to the idea of multiechelon simulation-based training. The brigade and battalion leaders and staff members reflected that satisfaction, indicating that their subordinates found the training exciting, interesting, and valuable.</p> <p>There were numerous comments on the value of including staff sections and other direct subordinates in the exercise, and some company and battalion leaders valued being able to participate with the higher echelon units. However, brigade and battalion leaders did not point out instances where they found that including subordinate units was of any significant value in their own training.</p> <p>During several discussions and interviews, however, the brigade commander and staff reflected on how to use a STOW-type exercise (or any multiechelon exercise) for the brigade. They maintained their enthusiasm and support for the training throughout the week at Fort Knox and during the months that followed. During his address to the Armor Trainer Update at Fort Knox in June 1998, the brigade commander reinforced his initial reactions to the exercise. He commented that everybody from the brigade commander down to the tank commanders thought they were the primary training audience. Such reaction is rare in multiechelon exercises.</p>

The commander further observed that having soldiers in the loop (that is, actually maneuvering and operating simulated tanks and other systems on the battlefield) caused him to approach command and control much more realistically than is done in most constructive simulation exercises. He had to issue orders and make decisions knowing that crews, rather than simulation icons, would have to interpret, react to and carry out those instructions. Orders had to be clearer and allow for the uncertainties found on even a virtual battlefield, but which don't exist on constructive simulation screens.

The increase in realism caused by having soldiers maneuvering and operating on the battlefield gave him a better appreciation for time and space considerations of controlling the battle. His decision cycle had to include troop leading time and reaction time for subordinates to implement changes, and account for more realistic time and space issues. He found that moving forces in virtual simulation, while still not the same as maneuvering on the actual terrain, was much more demanding and realistic than what is found in constructive simulation exercises or purely command post exercises.

It is not possible to separate general satisfaction, a result of being included in a high intensity experience, from anticipation of specific training value. The commander's wish to incorporate the training in his annual training activities speaks strongly to the training value of the exercise. While this does not lead to definitive conclusions regarding use of STOW-type exercises in a full unit training strategy, it does suggest that such conclusions may be drawn in future studies.

Duplication of existing simulation-based training programs

The STOW-ET was constructed as a hybrid of the VTP, the COBRAS BSE, and the COBRAS BBSE, and thus duplicates many features of those existing training programs:

- Like the VTP, it integrates activities of the support platoon and scout platoon in addition to the maneuver battalions, and places training audience members in a virtual environment. It also takes from the TSP for the VTP most of the SIMNET and ModSAF control guidance.
- It shares with the BSE a deliberate focus on the military decision-making process, as well as the tactical scenario for the DATK.
- As with the BBSE, the primary focus is on the brigade and battalion activities and interactions during planning, preparation, execution, and consolidation and reorganization.

The main difference between the VTP, BSE, and BBSE programs as compared to the STOW-ET, is that the STOW-ET allows platoon through brigade staff audiences to train simultaneously. However, the question remains: Is there an advantage to multiechelon (platoon through brigade), simulation-based training? Addressing that question would require a more systematic front end analysis of multiechelon missions and functions, to determine which training objectives cross echelon boundaries in ways that require multiechelon collective training. It would then also require fairly rigorous experimental design, reliable and valid performance criteria and means for measuring them, and control of extraneous variables.

**Recommendations
Concerning
Assessment of
Training Value**

Because it was a trial of both the technology and the TSP requirements, the STOW-ET was not considered to be the appropriate laboratory for training value assessment. However, measures of participant perceptions of value and perceptions of exercise utility in a training calendar give some indications of potential value. Further research is needed to assess this potential, and, as stated earlier, further development will be needed to support such research.

The recommendations below are intended to provide direction for additional research on training value in STOW-type exercises.

***1. Seven specific areas
should be addressed in
research on STOW
training value.***

Insights gained from the STOW-ET include the identification of training opportunities that are not addressed in other simulation-based exercises. The following seven areas, if explored and developed in a STOW-based exercise, may provide capabilities that improve the quality of brigade and battalion training.

- **Battle Damage Assessment (BDA):** Assessing the effects of action on the enemy is essential to painting an accurate picture of the enemy composition and capabilities. Observation, confirmation, reporting, recording, and consolidation start at the crew level and are applied through brigade. BDA must be reported to and recorded by the staff after each direct fire encounter with the enemy, and is also required as part of every indirect fire mission and air strike. In SIMNET, soldiers can maneuver on the battlefield and report battle damage as they see it, a capability that makes BDA a realistic training opportunity. While battle damage can be estimated in BBS, the requirement to obtain BDA from forces on the ground versus reading it off a screen should enhance the requirement for all levels.
- **Command and Control:** During crucial parts of the engagement or mission, the brigade commander physically locates where he can best assess and influence the conduct of the battle. This will often be co-located with the main TF commander or on a piece of key terrain overlooking the action. The DRS and virtual links allow the brigade commander to position himself and to see what key units, and the enemy, are doing on the ground. This ability, which does not exist in BBS, allows for more realistic interaction of the brigade commander with his subordinate commanders and places a more realistic requirement on the staffs in integrating command and control into their battle tracking.

- **Commander's Reconnaissance:** The commander, as the most experienced and best qualified person in the brigade, needs to get a "feel" for the battlefield during the planning process. The results of the commander's reconnaissance should be reflected in his initial guidance and in his course of action selection. This reconnaissance should take place early, very soon after the order is received. Properly conducted and integrated, it becomes an important factor in the MDMP process. In BBS-based exercises, the commander cannot access the virtual ground that he must fight on. Selected members of the staff such as the S3 and S2 should reconnoiter as well, time and resources permitting. A commander may follow up with a reconnaissance at specific points in the planning process, often including subordinate commanders or selected staff. The DRS and STOW links permit the commander and others to conduct reconnaissance several times during the planning phase.
- **Land Management:** The coordination of space and time on actual terrain is a problem in brigade operations. This is an S3 responsibility, but involves coordination with all combat support and CSS assets assigned to, supporting, or operating in the brigade area of operations. Restricted terrain highlights land management problems. Land management also becomes a vital issue when timing between movements of maneuver units is not carefully specified in the OPORD, rehearsed, and coordinated by brigade in execution. It is a problem often not faced in constructive simulation because space (terrain) conflicts have no effect. However, with a TF maneuvering on the virtual terrain, these problems may surface, depending on how realistically combat support and CSS resources are portrayed in the virtual realm.
- **Battle Monitoring:** During crucial parts of the mission, such as the counter-reconnaissance fight or the execution of the breach, it is often very difficult for the brigade staff to get an accurate picture of what is occurring from reports they receive through the TF CPs. One technique is to place a brigade radio on the subordinate unit command frequency (task force or company team) and directly monitor the action. In the STOW environment, frequent "real" message traffic will be generated by soldiers in the virtual simulators. If existing communications deficiencies can be overcome, this could provide an opportunity for more realistic situational awareness.

- **Indirect Fire Support:** Fire support is dependent on ground observers. The ground observer provides details and controls that let the brigade fire support officer (FSO) prioritize fires and react to a changing tactical situation. Observed fire allows adjustment of that fire for greater effect, including repeat missions, to ensure targets are neutralized. Observed fire also minimizes indirect fire fratricides because the observer should know the friendly force locations. The ability to coordinate control of fires down to the lowest level should provide more realistic training.
- **Reconnaissance Tracking:** The brigade issues a reconnaissance order to the TF to meet certain brigade priority intelligence requirements (PIR). The TF usually must implement these PIR through its scout platoon, sometimes augmented by other assets. The brigade must monitor the reconnaissance effort to ensure that the assets are in place, operational, replaced if lost, and that the PIR is answered or otherwise resolved. The brigade and TF both make continual modifications in the requirements or in the assets as the situation changes. The virtual environment allows the reconnaissance plan to be “played-out real time” and to be affected by “real” events such as enemy interdiction of assets, assets getting lost, or assets not observing the PIR. Real life adjustments must then be made. PIR should be realistically addressed in virtual environments. The linkage of SIMNET crews on the ground with the TF staff, up to brigade, allows this information flow to occur.

2. Assessment of training value will require continued use of STOW exercises.

A formal assessment of training value would enable researchers to determine the ways in which linked simulation-based exercises benefit users. Benefits must be examined for different types of tasks as well as for different segments of the candidate training audience.

Use of a STOW-type exercise, even under experimental conditions, is likely to be perceived by units as a good use of their training resources. If they continue to sign up for using the exercise, it will be possible to evaluate and improve the technology and the TSP. And if the technology and TSP continue to improve, it should be possible within the next year to conduct a more formal training value assessment. Full experiments will likely never be realized, but each test and data collection will carry researchers closer to definitive answers.

SUMMARY

The STOW-ET implementation demonstrated that it is possible to create a STOW training model and system. But a single trial of a high-technology training exercise, where the technology and corresponding support components are in place just in time for the exercise, is not sufficient for drawing valid conclusions about training value, support requirements, or technology needs. Further research is required to determine what the training model should look like and whether STOW-type training will provide sufficient training value to justify the cost.

To continue the research on the value of the training, additional trials must be conducted with upgraded technology and TSPs. A series of such trials, each building on the previous, is suggested to provide insights into the potential value and cost of such exercises.

To enter into such a series of trials requires an assessment that the potential for training value in linked simulation-based exercises exists, and that the potential is likely to be worth the costs associated with both the trials and the eventual implementation. It is the considered opinion of the evaluation team, based on the STOW-ET, that such potential exists.

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ACRONYMS AND ABBREVIATIONS

1SG	first sergeant
AAR	after action review
ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
ARPA	Advanced Research Projects Agency
ARSI	ARPA Reconfigurable Simulator Initiative
ATCCS	Army Tactical Command and Control Systems
AVLB	armored vehicle launched bridge
BBS	brigade/battalion battle simulation
BBSE	brigade and battalion staff exercise
BDA	battle damage assessment
Bde	brigade
BFV	Bradley Fighting Vehicle
BLDG	building
BSE	brigade staff exercise
CLS	contractor logistics support
COBRAS	Combined Arms Operations at Brigade Level Realistically Achieved Through Simulation
CP	command post
CSS	combat service support
CTC	Combat Training Center
CTCP	combat trains CP
DATK	deliberate attack
DRS	desktop reconfigurable simulators
DTDD	Directorate of Training and Doctrine Development
EXCON	exercise control
FIST-V	fire support team-vehicle
FM	frequency modulation
FSB	forward support battalion
FSO	fire support officer
FXXITP	Force XXI Training Program
HMMWV	high mobility multi-purpose wheeled vehicle
ID	infantry division

JSIMS	Joint Simulation System
JSTARS	Joint Surveillance Target Attack Radar System
M	mechanized
MDMP	military decision-making process
MICLIC	mine clearing line charge
ModSAF	modular semi-automated forces
MSE	mobile subscriber equipment
NSC	National Simulation Center
NTC	National Training Center
O/C	observer/controller
OPFOR	opposing forces
OPORD	operations order
OPTEMPO	operational tempo
PIR	priority intelligence requirements
RCVS	Reconfigurable Combat Vehicle Simulator
recon	reconnaissance
S2	brigade intelligence officer
S3	brigade operations officer
SIMNET	simulation networking
SIMNET-D	SIMNET - Developmental
SIMNET-T	SIMNET - Training
SOCT	Senior Observer Controller Team
STOW	Synthetic Theater of War
STOWEX	STOW Exercise
STOW-ET	STOW Exercise Trial
STRICOM	Simulation, Training, and Instrumentation Command
TAC	tactical command post
TACFAX	tactical facsimile
TF	task force
TSP	training support package
VTP	Virtual Training Program
WARSIM	Warfighters' Simulation